Space Weather Technical Forecast

Issued on Friday 27 December 2024 at 12:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity at GOES16 reverted to Low, with occasional upper-tier C-class flares observed, peaking with a C9.6 at 26/1845UTC from an unnumbered region near the eastern limb. The main sources for this activity included AR3938 in the northeast, AR3936 in the north-centre and the aforementioned arriving region(s) near the solar equatorial eastern horizon.

There are now up to 14 sunspot regions on the disc, with two unnumbered regions near the eastern solar horizon and the redevelopment of AR3929 in the northwest. AR3926 is now becoming difficult to discern near the southwestern limb. There are five main sunspot regions on the Earth-facing side at present, all with Zurich D- or E-group classifications. Trends observed in the period have included a spreading and consolidating tendency in AR3928, while AR3933 to its immediate south showed penumbral areal decay but some minor intermediate spot emergence. AR3932 near south-centre disc saw a group immediately west of it fade, as did its main penumbral leader, however the trailing spots showed the reverse trend, and it is here that a possible weak Mt Wilson delta spot may reside. AR3936 in the north-central disc presented as a congested Eac/Beta-Delta, with areal decay in its trailing penumbra, but strong and sustained growth in the leading complex, with a delta again potentially present. The final group of note was AR3938 in the northeast, whose development was mainly in configurational changes rather than wholesale growth.

The current southern hemisphere far side is proving a fertile breeding ground for CMEs, with a good many observed through the Christmas period heading south and later southeast from the far side, implying the presence of a large and active region here - potentially of note into the New Year period.

Front-sided activity was more limited (with the caveat of continuing lengthy imagery gaps in H-Alpha, and only periodic triangulating STEREO A COR2). There have been a large number of CMEs on coronagraphs in the period to render analysis more difficult, however the salient points under investigation include a GOES16 SUVI 304 possible filament eruption from near AR3938 in the northeast 26/1900UTC. Secondly, on H-Alpha, a possible weak disappearing filament left the vicinity of AR3938 at 27/0800UTC - there is not yet imagery available for this later event.

No new CMEs are confirmed as being Earth-bound at the time of writing.

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Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR showed a slow regime, with background solar wind speeds falling from 375 to 350km/s. The solar wind density was within normal background levels in single figures ppcc, and the IMF was below 5nT. The north-south component was erratic between limits of +/-4nT. The phi angle was mostly negative (towards the Sun). The net result of the above solar wind measures was provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 showed a continuing gradual decline below 1pfu, well below the S1/Minor Radiation Storm threshold.

High energy electron flux (greater than 2MeV) at GOES16 was at Moderate levels, peaking at 26/1615UTC near 868pfu. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold on a flat trend. The 27/0001UTC observation was 3.4e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Occasional M-class flares are Likely, with a Slight Chance of isolated X-class flares throughout.

Solar Wind / Geomagnetic Activity: No coronal hole fast winds nor CMEs currently feature in the forecast. Confidence in this assertion is lower than usual given the weight of numbers of recent CME events on the whole Sun.

Geomagnetic activity is expected to be mainly Quiet, but with a Slight Chance of Active intervals should any glancing CME effects occur - perhaps more likely on 28 and 29 December.

Energetic Particles / Solar Radiation: There is a Slight Chance of S1/Minor Radiation Storm or greater enhancements during the period. In the absence of any further notable flares, ongoing proton counts should continue to ease towards background levels in the coming days.

Electron flux levels remain Moderate but are expected to gradually ease into the period. There remains a Slight Chance of exceeding Active Fluence levels, particularly to start the period, but this risk gradually reducing.

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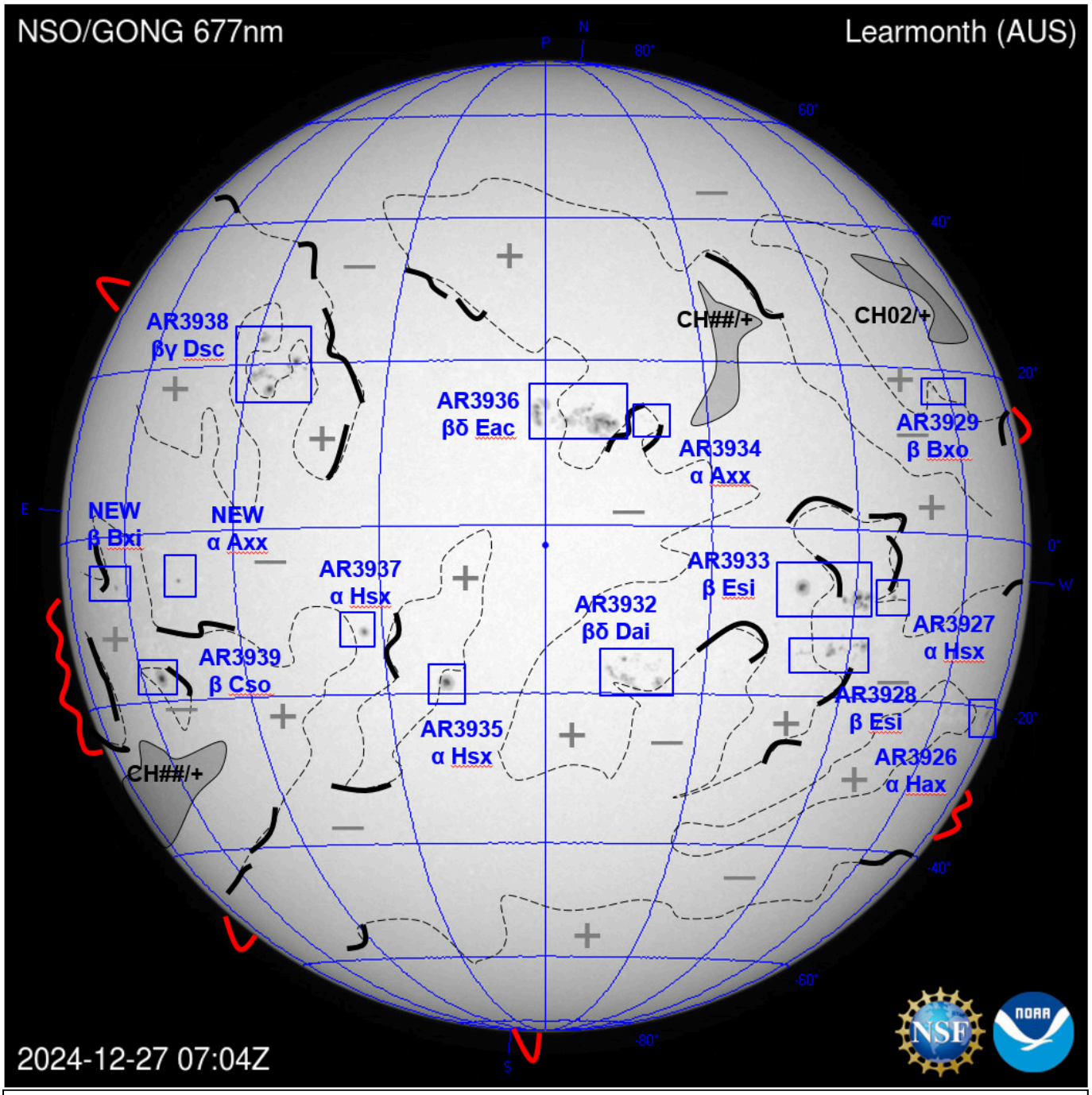
Figure 1: Solar synoptic map, valid 27/0704UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No CMEs and no coronal hole fast winds are now due in the forecast period.

As stated in the solar analysis section, there have been numerous CMEs in recent days, some of which have been analysed close to the Earth-Sun line and may present the risk of minor glancing enhancement into the period. As such confidence in this aspect of the forecast is lower than usual.

Solar winds have now declined to background levels after the recent connection to CH01/-. Some further enhancement is possible but unlikely on Day 1 (27 Dec) from CH02/+ located in the northwest disc. MOSWOC Enlil output persists in showing a HSS from an uncertain source at the start of this period, but this is viewed as erroneous with current output not preferred - solar winds are instead expected to remain at Background levels to start the period. An increase to perhaps Slightly Elevated levels is possible should any of the CMEs produce close passes - the risk of G1 shown in the tables has been narrowed to indicate the time period where this is considered most likely - albeit not the 'favoured solution', with a slow regime and Quiet geomagnetic activity probably seeing out the four days instead.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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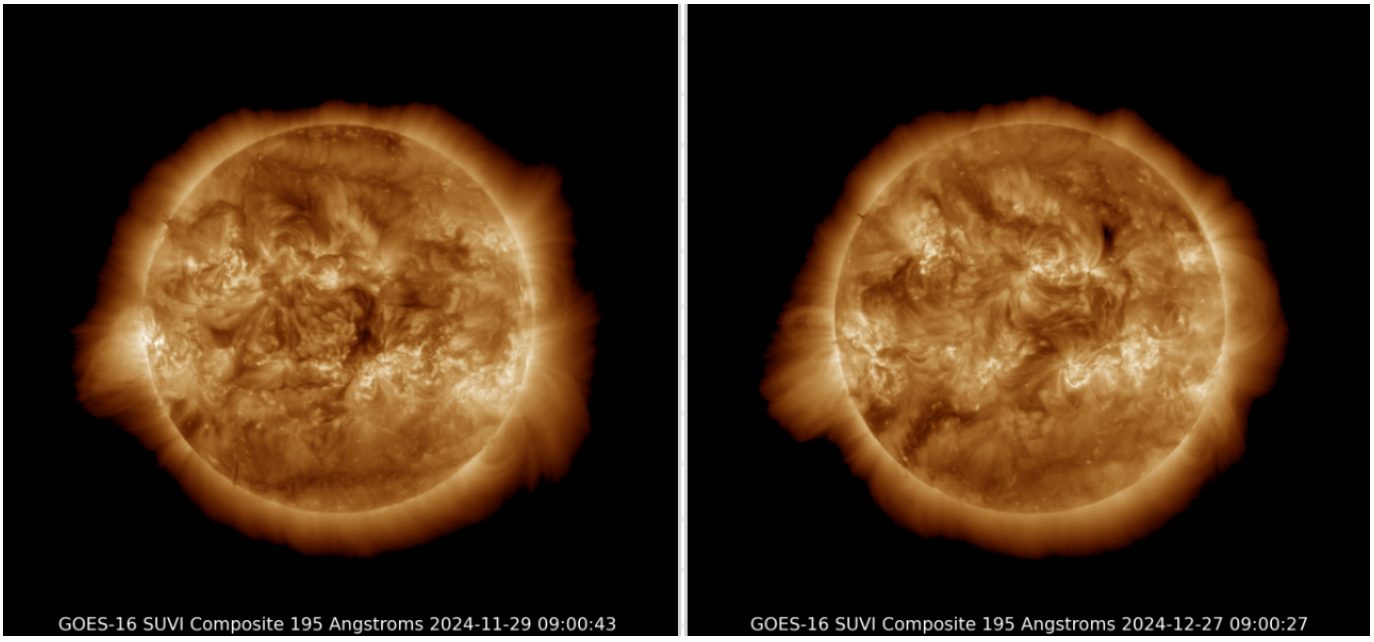
Figure 2: Past and current rotations in GOES16 SUVI 195 imagery, showing little in the way of coronal holes, and those that are present are not persistent.



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Radio Blackouts - X-Ray Flares

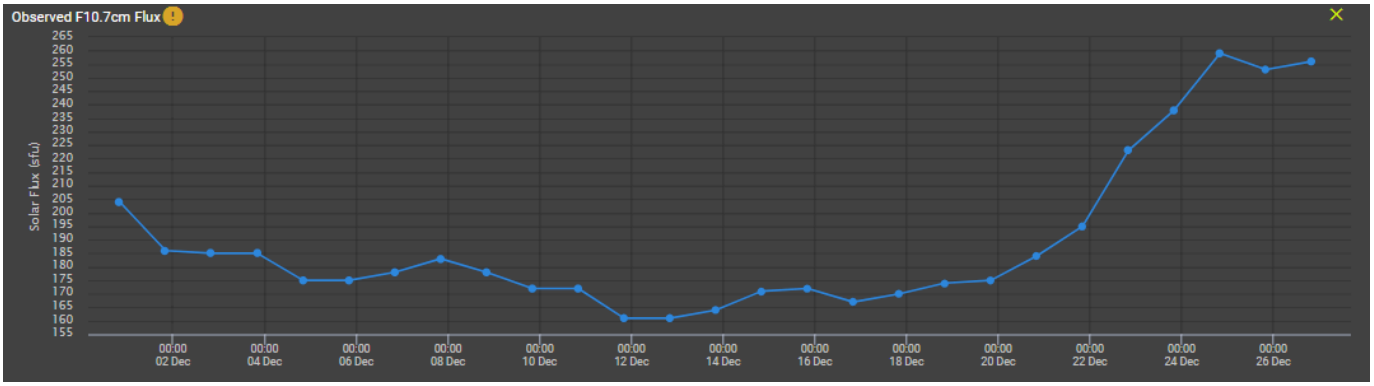
The Penticton 10.7cm flux has been on a strong rising trend in recent days as the number of larger sunspot regions has increased, reaching a peak for this rotation, but values perhaps showing sign of some stabilisation with slight decline among a number of the previously large groups.

Recurrence suggests the potential for further sunspot regions to round the eastern limb later in the period, with this supported by recent far-side CME activity although far-side sounding output is not showing any significant regions (perhaps now because of proximity to the limb where soundings have a minimum ability to detect such regions - with limb flux looping perhaps a better guide). None of the larger sunspot regions leave the disc in the four-day forecast period.

The assessment of any new regions notwithstanding, flare risk looks to remain elevated during the period and occasional M-class flares remain Likely, with a Slight Chance of X-class flares maintained throughout, pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	70	70	70	70
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: Past rotation in Penticton 10.7cm flux, showing current highs rivalling a peak last seen at Hallowe'en 2024.



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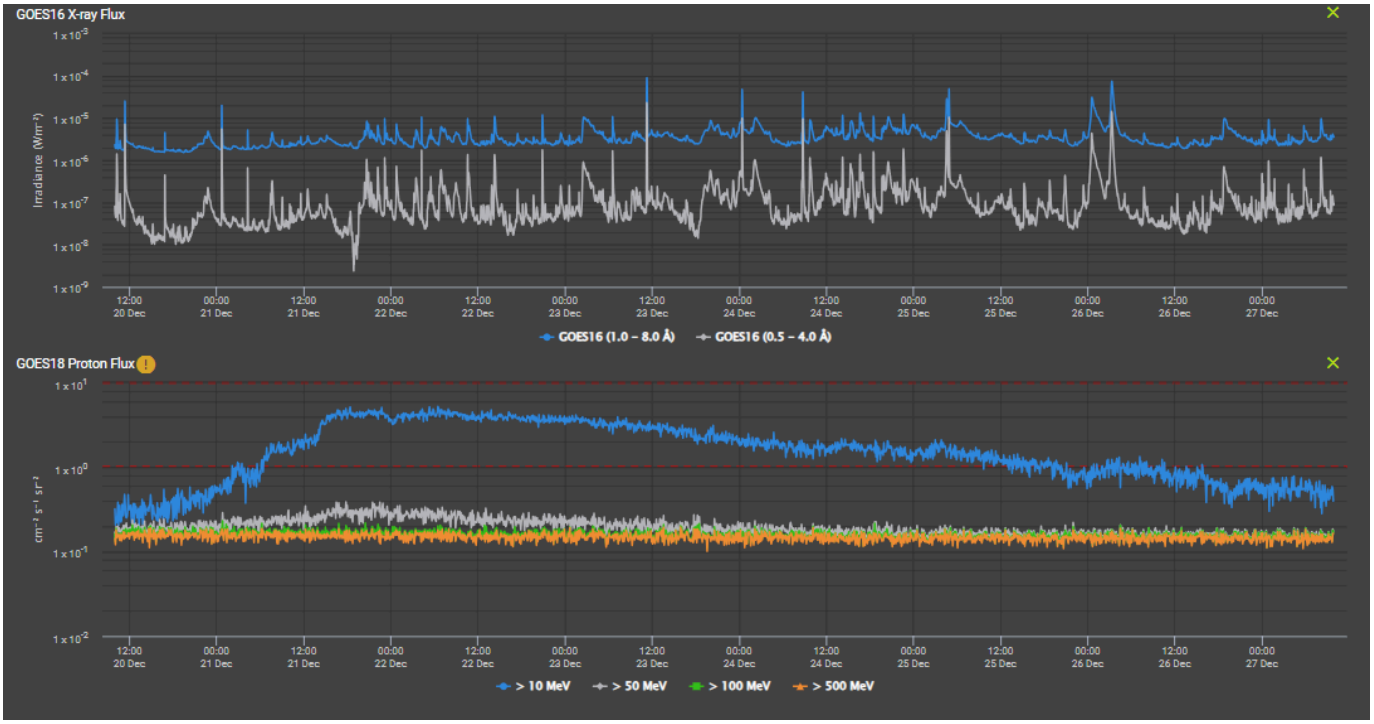
Solar Radiation Storms (High Energy Protons)

High energy proton counts are slowly declining and should continue to ease towards typical background values in the coming days. There remains a Slight Chance of S1/Minor Solar Radiation storms or greater should any significant flares occur from the larger regions on the disc as they move into more favourable locations for connection with Earth. The most likely enhancement in the near term would perhaps be a similarly slow and damped rise tied to far-sided activity, although the large region responsible for the spate of recent far-sided CMEs is now nearing the least-well connecting part of the Sun.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 X-ray flux and GOES18 high energy proton flux over the past week, with the probable source of the current enhancement far-sided given the protracted rise and fall and long-duration damped energy spectrum.



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High Energy Electrons (≥ 2MeV)

Current high energy electron flux has been at Moderate levels in the last 24 hours. Now that the solar wind pressure from CH01/- has eased and geomagnetic activity has fallen significantly, a steady state diurnal oscillation ought to be near at GEO. With no further drivers to increase electron populations, fluence will now most likely remain below Active throughout. MOSWOC REFM is now showing a steady forecast through the next three days, which is considered good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	5	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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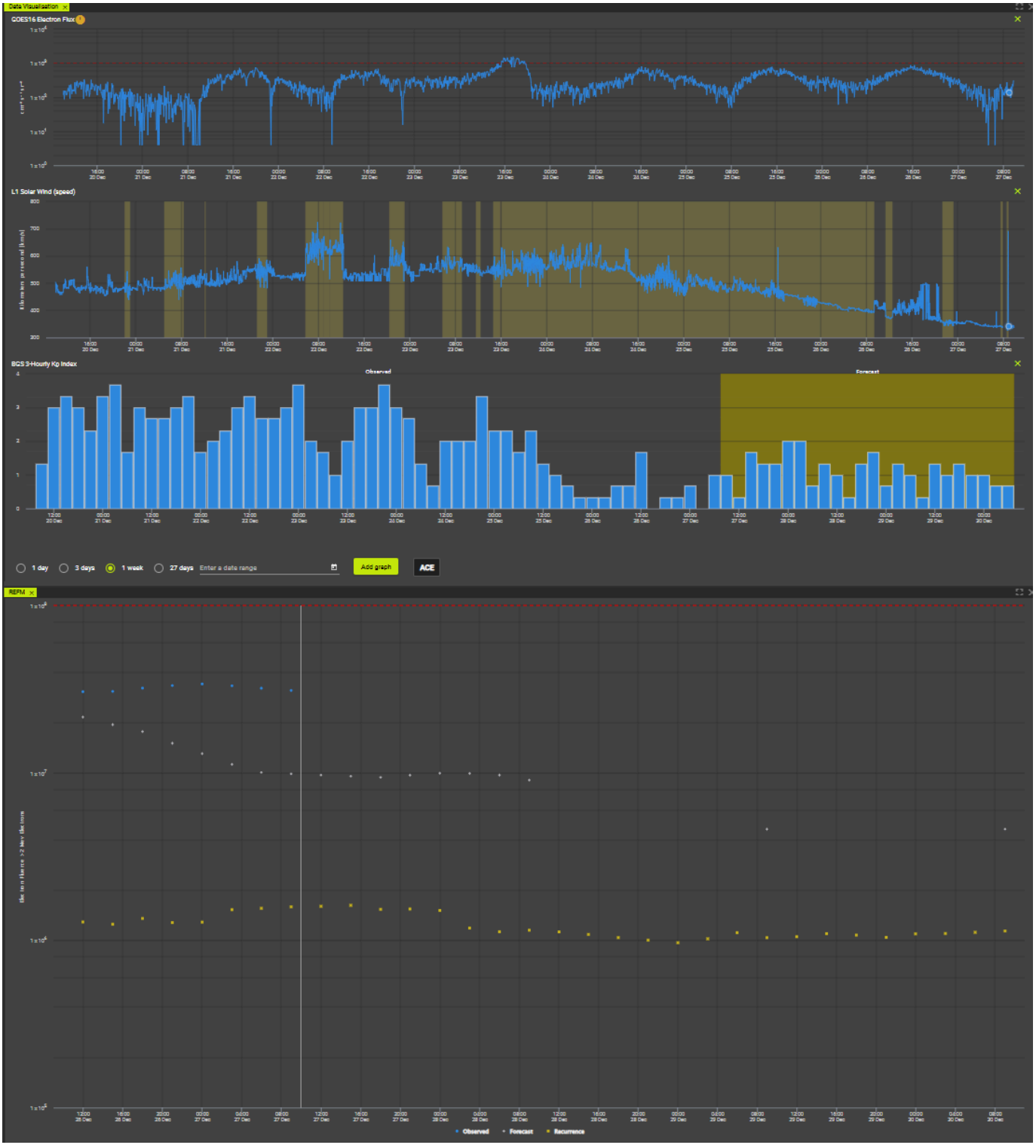
Figure 5: Past week in GOES16 high energy electrons, L1 solar wind speed and BGS-recorded Kp activity. Also shown is the latest MOSWOC REFM, which now ought to be providing a more useful steer in forecast conditions given the likely absence of further solar wind drivers in the period.



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